Instruction Handbook for....

FAC # 3384
SER # 710
ITEM # 2

AIL TYPE 7012
COAXIAL NOISE GENERATOR

BAYTRON SYSTEMS CORP.
1720 Newport Circle
Santa Ana, Calif. 92705

March 1965

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CUTLER-HAMMER

AIRBORNE INSTRUMENTS LABORATORY
DEER PARK, LONG ISLAND, NEW YORK 11729

CONTROL AIL DIVISION

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I. INTRODUCTION

The AIL Type 7012 Coaxial Noise Generator is an accurate source of random noise over the frequency range from 2 to 5 Gc. It consists of an argon-filled, gas-discharge tube coaxially mounted in a helical transmission line. Type-N connectors are provided for making connections to the external RF circuit.

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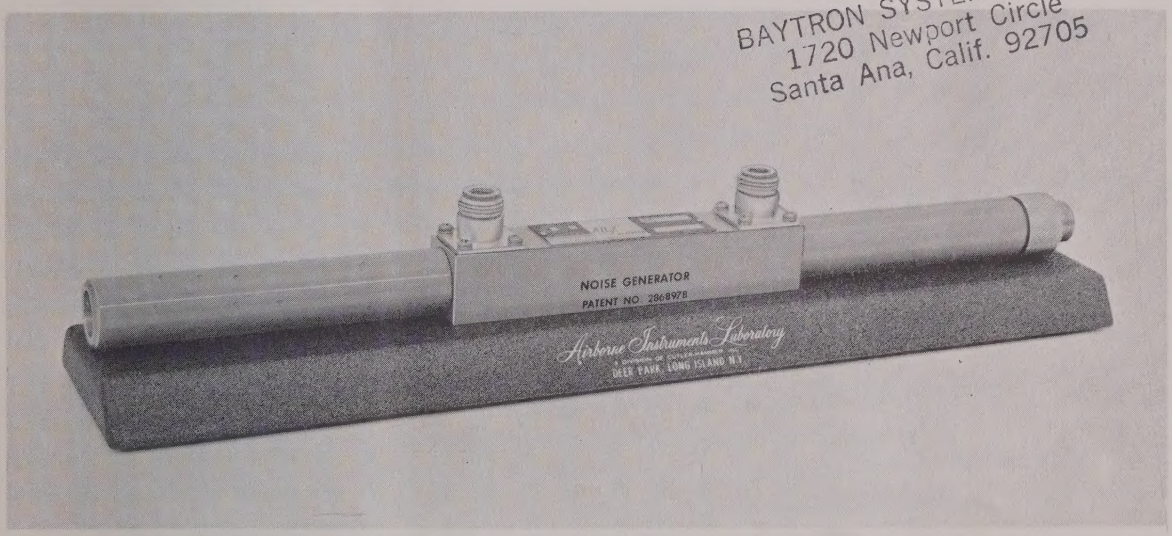

FIGURE 1. AIL TYPE 7012 COAXIAL NOISE GENERATOR

II. SPECIFICATIONS

Frequency range	2 to 5 Gc
Tube ratings	
Relative excess noise temperature	~~15.9~~ 15.65 ± 0.25 db
Operating current	175 ma
Firing voltage	~2 kv
SWR*	
Fired	1.5 maximum
Unfired	2.0 maximum
Insertion loss	
Fired	11 db minimum
Unfired	1.7 db maximum
Size	3 × 3 × 16 inches
Weight	2.5 pounds

* When terminated with a 50-ohm load having an SWR of 1.05 or less (see Figure 2).

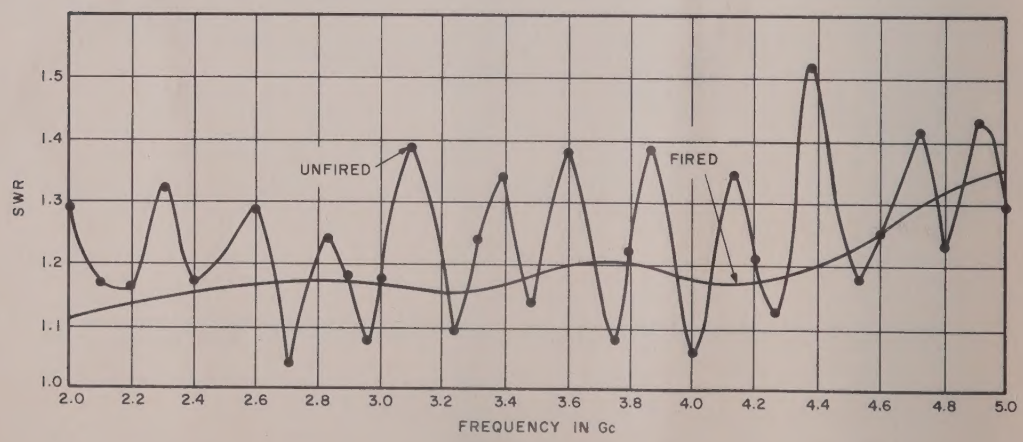

FIGURE 2. TYPICAL SWR (FIRED AND UNFIRED)

III. OPERATION

The Type 7012 can be operated with the AIL Type 7111 Power Supply to make manual noise figure measurements.

When operated with the AIL Type 74A Automatic Noise Figure Indicator, both manual and automatic noise figure measurements can be made.

The Type 7012 is connected to the power source by means of the cathode connector (4, Figure 3) and anode connector (1, Figure 3).

The noise-tube current must be set to approximately 175 ma for CW operation. This current value is not critical because the ratio of the change in output power to the change in current is about -0.005 db/ma.

One of the output connectors (2 and 3, Figure 3) must be terminated in a 50-ohm load with an SWR of 1.05 or less. This termination establishes the reference temperature for noise figure measurements. The remaining output connection is used to couple the noise power to the device being tested.

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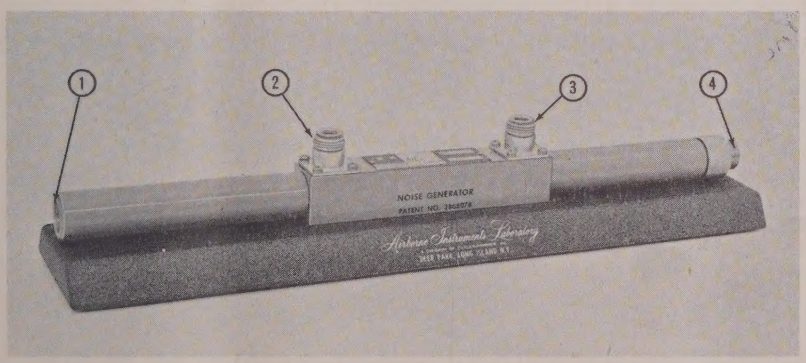

① ANODE CONNECTOR
② OUTPUT CONNECTOR
③ OUTPUT CONNECTOR
④ CATHODE CONNECTOR

FIGURE 3. PARTS LOCATION

IV. THEORY OF OPERATION

The Type 7012 can be used in any of the standard setups for performing noise-figure measurements of receivers in the 2 to 5 Gc range. Basically, these methods involve the measurement of the Y factor, which is defined as the ratio of (1) the noise power from the receiver under test when terminated in a source impedance, at temperature T_2, equivalent to the impedance from which it is intended to work, to (2) the noise power when terminated in the same value of impedance at temperature T_1. The full expression for the noise figure of a receiver is then:

$$F = \frac{B_O}{B}\left[\frac{\left(\frac{T_2}{T_O} - 1\right) - Y\left(\frac{T_1}{T_O} - 1\right)}{Y - 1}\right] \qquad (1)$$

where

T_2 ≡ effective temperature of the discharge generator in its fired condition (degrees Kelvin),

T_1 ≡ temperature of the termination when the discharge lamp is unfired (degrees Kelvin),

T_O ≡ 290°K,

B_O ≡ overall noise bandwidth of the receiver under test--including image, harmonic, and other spurious responses,

B ≡ useful-channel bandwidth of the receiver.

This expression generally can be reduced to

$$F \equiv \frac{\left(\frac{T_2}{T_O} - 1\right)\frac{B_O}{B}}{Y - 1} \qquad (2)$$

Since T_1/T_O is usually almost equal to unity. If B_O/B is also equal to 1, the relation between F and Y is simply:

$$F = \frac{T_{ex}}{Y - 1} \tag{3}$$

where

$$T_{ex} = \frac{T_2}{T_O} - 1 \tag{4}$$

15.65 ~~15.9~~ db. The tube used in this generator has a rated output of The value of the excess noise temperature (T_{ex}) of the generator varies from one type of gas-discharge tube to another and, due to variations in the coupling efficiency of the mount, it also varies across the operating frequency range. The actual value of T_{ex}, including corrections for these variations, may be obtained from Figure 4. Using this value of T_{ex} and the measured value of Y, the measured noise figure may be obtained by reference to Figure 5.

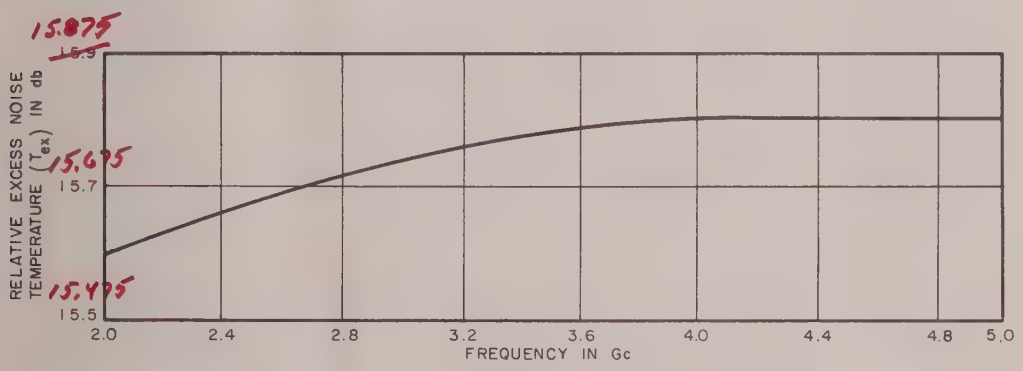

FIGURE 4. TYPICAL RELATIVE EXCESS NOISE TEMPERATURE

The curve shown in Figure 4 represents typical performance for this generator. An accurate determination of the excess noise power may be obtained by measuring the insertion loss of a generator when the gas-discharge tube is fired and again when it is unfired.

These values of hot and cold insertion loss can be used to determine the decrease in the excess noise power of the noise generator by referring to Figure 6. The correction factor obtained from

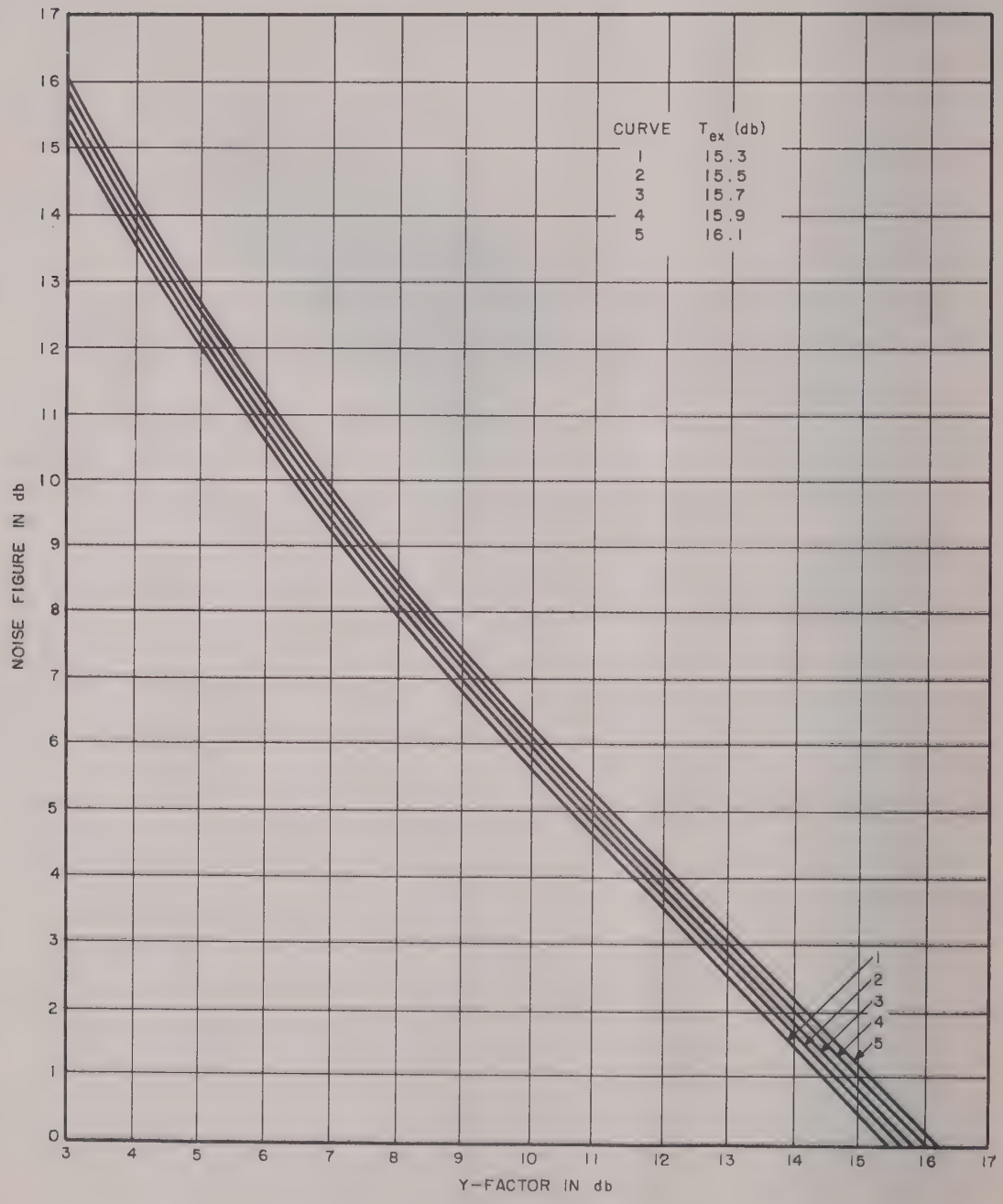

FIGURE 5. MEASURED NOISE FIGURE

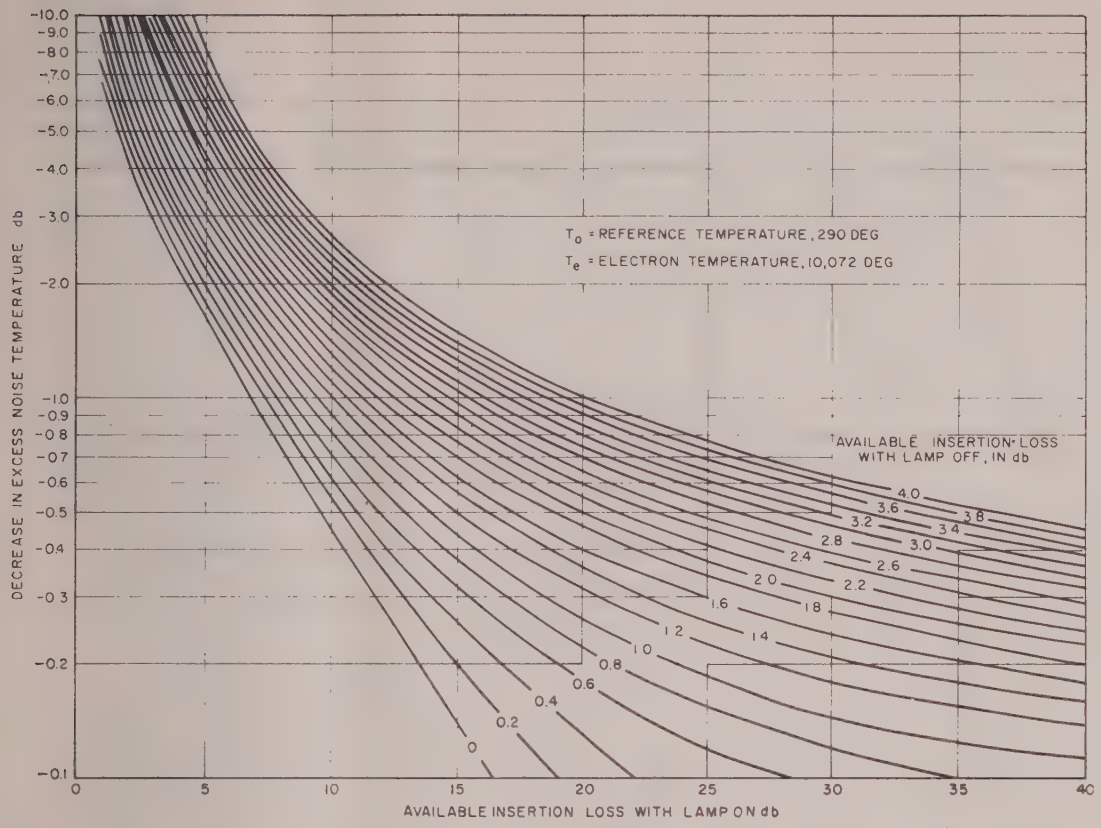

FIGURE 6. DECREASE IN RELATIVE EXCESS NOISE TEMPERATURE AS A FUNCTION OF NOISE SOURCE INSERTION LOSS

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these curves should be subtracted from the excess noise power of the actual tube used in the noise generator, which is ~~15.9~~ 15.65 db.

If B_o/B is not equal to 1, a correction must be added (in db) to the value obtained in Figure 6 equal to 10 log (B_o/B). For example, if the receiver has an image response equal to the desired signal response (B_o = 2B), the correction to be added is 3 db.

Usually, the most accurate means for determining Y is to use the IF attenuation method, as indicated in Figure 7. An IF output is taken from the receiver under test at some stage where significant additional noise will not be contributed. With the noise generator off, the output from the postamplifier is adjusted to obtain a convenient reading on the output indicator. The generator is then turned on, and the IF attenuator is adjusted to return the output indicator to the preceding value. The change in the attenuator readings between the two

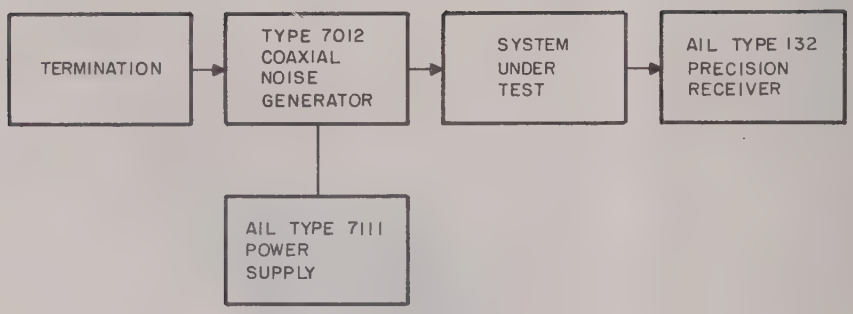

FIGURE 7. SETUP FOR MEASURING NOISE FIGURE

conditions is precisely the Y-factor, provided that all circuits up to the attenuator are linear and that the gain of the overall system has remained constant during the two measurements.

The accuracy of the measurement also depends on the accuracy of the attenuator that is used. The AIL Type 30 IF Attenator is excellent in this application. This attenuator has been incorporated in a 30-Mc (or 60-Mc) receiver (AIL Type 132), which also includes the postamplifier and output indicator.

To obtain accurate results, the Type 7012 should be terminated in a matched load with an SWR of less than 1.05. Otherwise, the impedance of the generator will not be well matched in the "on" and "off" conditions, and the measurements may be invalid.

In some cases, it is desirable to be able to align the receiver under test before each measurement. In this case, a carefully matched 20-db pad can be connected to the unused terminal in place of the 50-ohm termination, and a signal can then be fed through the pad and noise generator to the receiver.

If the generator is to be used continuously, it may cause the termination temperature (T_1) to rise significantly above $290^{\circ}K$. If extreme accuracy is required and if the receiver noise figure is

low (below 6 db), this increase in termination temperature may require a correction to the measured noise figure computed from equation 2. Equation 1 must then be used; the correction is seldom significant.

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V. MAINTENANCE

Maintenance of the Type 7012 Noise Generator is limited to replacement of the argon-filled gas discharge tube.

To replace the tube, proceed as follows:

1. Remove four screws from bottom of unit and separate the main housing from the base.
2. Unscrew knurled retainer on cathode end.
3. Remove spring and shorting button assembly from cathode end.
4. Grasp cathode housing (tubular section about 4 inches long) and unscrew it from the main block. A strap-wrench may be used if necessary; however, in most cases, this can be done by hand.

CAUTION

Hold the tube with two fingers by the glass portion--not by the base. The amount of force required to remove the tube could possibly be sufficient to break the seal between the tube and its base.

5 Carefully remove tube from mount while applying a slight twisting motion.

To insert a new tube, reverse this procedure. When properly seated, the neck of the tube will be almost even with the end of the mount assembly leaving only the large "bottle" portion of the tube exposed.

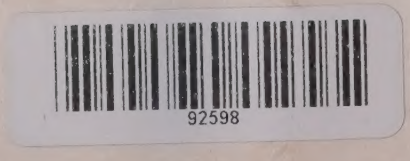
If any further repairs are necessary, return the noise generator to the factory in accordance with the following instructions.

Write first to the AIL Sales Department, giving complete information concerning the nature of the failure and the manner in which the equipment was used when failure occurred. Also provide the TYPE and SERIAL NUMBERS of the unit. Special instructions will then be supplied to the customer for shipping the unit back for

repairs. All equipment should be packed and shipped, in accordance with these instructions, with transportation charges prepaid. A failure report should accompany shipment of the equipment.

VI. PARTS LIST

The argon-filled gas-discharge tube (AIL Part No. 206800) is the only replaceable part in the Type 7012 Coaxial Noise Generator.



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